4. OPERATION OF THE SRP

4.1 Health and Safety Precautions

WARNING

THERE IS 110 VAC ELECTRICAL POWER IN VARIOUS ELEMENTS OF THE SRP SYSTEM EVEN WHEN THE POWER SWITCH IS IN THE OFF POSITION.

This does not present any hazard during normal operation, but must be taken into account if repairs/maintenance is being performed.

Assure that the temperature in the space used to house the SRP is well controlled or the instrument's electronics will fluctuate and not stabilize. Also avoid pinching the gas delivery lines when assembling the SRP, as pressure build-up may damage the instrument, and it will not operate properly. Make sure there is adequate ventilation (connected to exhaust manifold or hood), when generating O_3 to avoid exposure to the O_3 being generated.

Exposure to O_3 should be As Low As Reasonably Achievable (ALARA); <10ppb.

Exposure Limits as listed in NIOSH/OSHA guide:

OSHA Permissible Exposure Limit (PEL) for General Industry: 29 CFR 1910.1000 Z-1 Table -- 0.1 ppm, 0.2 mg/m^3 TWA

OSHA Permissible Exposure Limit (PEL) for Construction Industry: 29 CFR 1926.55 Appendix A -- 0.1 ppm, 0.2 mg/m^3 TWA

OSHA Permissible Exposure Limit (PEL) for Maritime: 29 CFR 1915.1000 Table Z-Shipyards -- 0.1 ppm, 0.2 mg/m^3 TWA

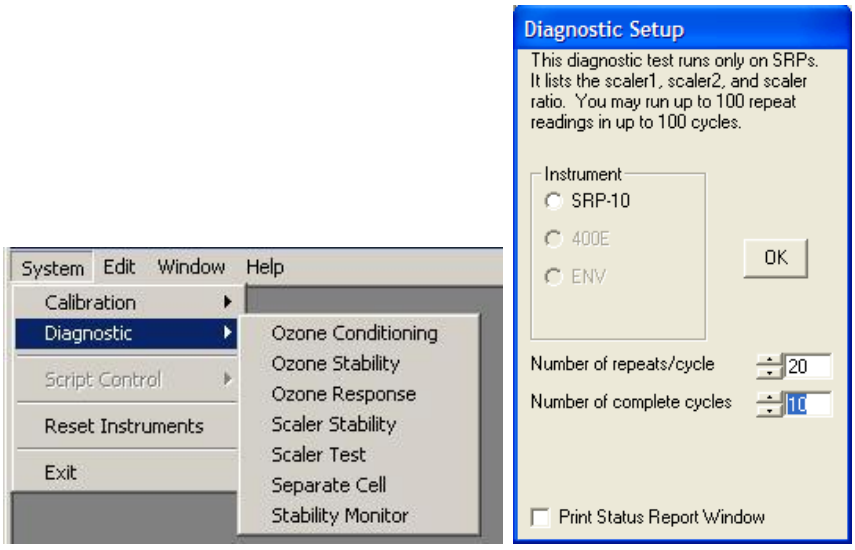
4.2 Performing Quality Control Checks

4.2.1 Prior to using the SRP for an official verification, the operator must document operational conditions by recording a number of quality control checks as outlined below and documented on the "SRP Operating Characteristics Data Sheet" (OCDS) following this section. The OCDS contains instructions and acceptance criteria that must be met prior to performing verifications.

4.2.2 Maintenance/repair work that is performed on the SRP should be recorded on the OCDS. Maintenance that is not measurement critical (items that would not affect SRP cell length, temperature measurements, or pressure measurements) is not typically recorded in the OCDS but in an operator general logbook to document any changes made to the SRP.

4.2.3 It is recommended that the OCDS be completed prior to an official verification in order to maintain a continuous record of how often adjustments are being made and why. An OCDS must have been completed within the previous 7 days prior to performing a verification. The OCDS serves to demonstrate that the SRP is stable and accurate before starting an official verification.

4.2.4 Diagnostic scripts can be accessed under the "***System/Diagnostic***" menu option as shown below. The Diagnostic form will appear when any of the diagnostic scripts are selected. The electronics module must be turned on for at least 15 minutes prior to engaging in these procedures. Select by clicking on the "System" from the Main Menu" located at top of the screen within *SRPControl* program. Then select "Diagnostic" then over to "Scaler Test", cycles every 5 seconds reading on the SRP for Scaler1, Scaler2, and scaler ratio for a request number cycles. The SRP electronics module should display numbers instead of "EEEE's" while cycling updated readings on the front panel of the electronics module.



4.2.5 If it is desired to "Restart", "Stop", or "Abort" the operation go to "System", "Script Control", and select "Restart", "Stop", or "Abort". **Note:** If you do select "Stop", the screen will display a message that states "Data May Be Invalidated".

4.2.6 Make sure that the SRP pump is not running during the following SRP temperature operational check (***Stability Monitor Must Be on for SRP Readings to Update).*** Install the STOLAB temperature calibrator into the temperature connector on the back of the electroni***cs*** module**.** Set the STOLAB unit to 30°C or 100°C and allow it to warm up for at least 15 minutes prior to performing temperature checks (see 4.2.16 after waiting period, continue on with the following pressure checks during this waiting period).

4.2.7 Proceed with pressure checks. Obtain a Druck DPI 705 Digital Pressure meter or its equivalent ambient pressure meter accurately with ± 0.1 mb. Again, make sure the SRP pump is not running during these procedures.

4.2.8 Make sure that the pressure switch on the front panel of the SRP is in the "cal" position. Observe the pressure reading (making sure it is stable) and record it on the OCDS.

4.2.9 Place the switch to the "run" position and record the pressure reading.

4.2.10 Record the identity of the lab pressure standard being used.

4.2.11 If either reading is not within specifications, then adjust both the zero and span adjustment screws to adjust readings.

4.2.12 To adjust the zero pressure setting, flip the switch to "cal" and adjust the number until it goes to 700 mb.

4.2.13 Flip the switch to "run" and adjust the number to match the laboratory standard.

4.2.14 Again, switch to the "cal" and readjust the zero position to the 700 mb, and then switch to "run" and readjust to the laboratory standard.

4.2.15 After each cycle, the measurement should be closer to the target numbers. Once the passing criteria are met, record these measurements on the OCDS. Note that when the numbers are out of control limit, increase or decrease the "run" or "cal" value to above or below the desired value. This may take more time, but it will allow for the desired adjustment to take place.

4.2.16 For temperature verification (should have STOWLab connected for at least 30 minutes prior), a NIST traceable voltmeter must be attached to the TP 2 (+) and the TP 14 (-) inside the electronics module (run mode).

4.2.17 Set the STOLabs calibrator to the 30°C or 100°C setting, set the voltmeter to the millivolt (mV) DC and record the reading on the OCDS. *This quantity is not typically changed; however, if it needs to be adjusted, refer to the Section 7.2 of this document for details on how to perform this adjustment.*

4.2.18 Set the STOLabs calibrator to the 0°C, set the voltmeter to the millivolt DC and record the reading on the OCDS. *This quantity is not typically changed; however, if it needs to be adjusted, refer to the Section 7.2 of this document for details on how to perform this adjustment.*

4.2.19 On the front panel of the electronics module, record the panel reading while the STOLAB is set to 30°C or 100°C. Use the front panel adjustment pot labeled "span" to adjust the observed temperature reading to within ±0.1°C of the standard (remember to close cover when done).

4.2.20 Set the front panel temperature switch to the "Cal" position (STOLAB calibrator should be set at 100°C), place two voltmeter probes into the front panel openings for temperature, and record the reading observed on the voltmeter (the voltmeter should be set at the millivolts DC range). Use the front panel "zero" adjustment pot to adjust the reading to between 0.1 to 1.0 mV.

4.2.21 Record the total counts observed from Cell #1 and Cell #2. These should be 90,000 – 250,000. *This quantity is not typically changed; however, if it needs to be adjusted, refer to the Section 7.5 of this document for details on how to perform this adjustment.* ***Note:*** *further QC checks are not possible until stabilization is obtained after this adjustment until 4 or more hours for proper stabilization between any adjustments made.*

4.2.22 On the computer screen, select "System", "Script Control" and "Abort" to stop operation running.

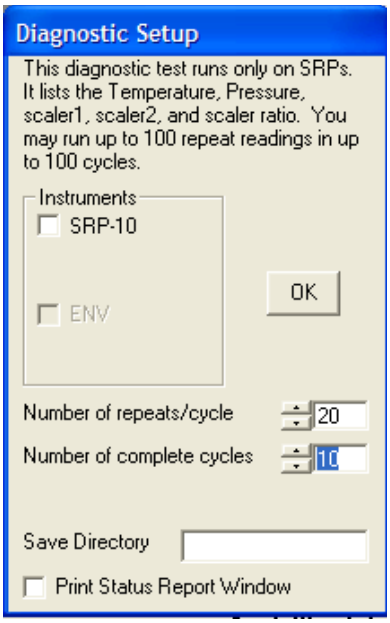
4.2.23 Now, go to the SRP display menu and "click" on the button within SRP controls that reads shutter "Open". It will display "closed" on that same button. This will close the shutter for the "Dark Count" readings. Quickly go back to "System", "Diagnostics", and select "Scaler". This will now display the "dark count" readings.

4.2.24 Record the counts observed on the electronics module. Allow it to run a couple of duty cycles to stabilize. If the counts are not between 5 and 20, adjust the scalers as described below, *refer to the Section 7.7 of this document for details on how to perform this adjustment.*

4.2.25 Go to "System", "Script Control" and select "Abort" to stop operation running.

4.2.26 Make sure the switches for temperature and pressure on the SRP electronic modules are both on "run". Once at the main menu, select "diagnostics" and select "stability monitor". Be sure to remove the STOLAB calibrator and reconnect the temperature cable. .

4.2.27 Go to "System", "Script Control", "Stability Monitor" and select the option for 10 sets, and 20 readings per set. Select instrument and any other options for printing and saving data. Select as appropriate. Click on "ok".



4.2.28 The "Stability Monitor" diagnostic procedure will take approximately 30 minutes. The Stability Monitor should automatically generate an Excel™ spreadsheet report after it has finished.

Examine the Excel™ spreadsheet. The last four of the ten total readings standard deviation values for Scaler 1 and Scaler 2 should be less than ***25*** and the standard deviation value for the ration should be less than ***0.00003***. If this is not the case, run the stability monitor again, then, troubleshoot. Attach a copy of the Stability Monitor report to the OCDS. *How to correct a problem if the SRP routinely fails this test:* There are two things that can affect the Stability Monitor Test. One can be the age of the source Lamp and the second can be the temperature of the source lamp. The new PID controllers can control the temperature to within 0.1 °C. If you observe a fluctuation greater than that then the PID Controller needs to be.re-tuned. Just press the green button and then scroll down to where it says Tune Off and change it to Tune On. You can also find the lamps optimal temperature where it will work most efficiently. A rule of thumb is that new lamps will like a lower temperature and an older lamp will need a higher temperature. To find the optimal temperature, set up the SRP as if you were going to run a Stability Test and start the Stability Monitor. Turn the temperature to the Source Block up just a little bit. On the newer Upgrades the temperature can be adjusted in 0.1 °C increments but on the older controllers it is just a slight turn of the dial. Now watch the Scaler counts. If they increase, then you will need to go higher with the temperature. If they decrease then you need to go lower with the temperature. Whichever direction you go the Scaler will keep increasing until it reaches a point where the Scalers will start to decrease. The temperature right at the peak Scaler count will be your desired temperature for the block. Also, before you start this check the position of the lamp. Move it in and out and turn it forwards and back to find the maximum power. If you end up with high Scaler counts then you can turn the power down to the lamp using the blue pot on the board. Once you optimize the lamp position and temperature it should pass with flying colors, but if it does not then put in a new lamp.

4.2.29 The following four pages are examples of the OCDS "*SRP OPERATING CHARACTERISTICS DATA SHEET". A* completed copy should be included with all verification data. A copy of a completed OCDS is included in ***Appendix B.***

Date:	SRP S/N:
Location:	
Region __ Project #:	
SRP Operator:	

Standards used for measurements

Parameter	Instrument	
Temperature		
Thermometer Electronics		
Electrical VDC:		
Barometric Pressure		
Flow:		

1. SRP WARM-UP TIME:

SRP Turned On: Allow for minimum 4 hour warm up.

Date:	Time:

STOLAB plugged into RTD port. Allow STOLAB 15 minutes to warm up.

Date:	Time:

QC Checks Started.

Date:	Time:	
Ambient room temperature:		^{o}C
Barometric Pressure:		mb

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2. SRP TEMPERATURE:

STOLAB Circuit Card (see Section 9.1 for proper installation)
1) Measurements are done at TP2 (+) and TP14 (-),
(2) Disconnect Sample Inlet and Reference Inlet from manifold or turn, Pumps off,
<STABILITY MONITOR MUST BE ON FOR SRP READINGS TO UPDATE>
(3) Set SRP to 'run', set STOLAB at 0^{o}C and set voltmeter to read mV DC.
Acceptable Range: Zero (0.0 and 0.1 mV)
Adjustment is the Zero Pot on STOLAB Circuit Card

	Unadjusted	Adjusted
Circuit Reading:	mV	mV

Set SRP to 'run', STOLAB at 100^{o}C or 30^{o}C and voltmeter to read volts DC.
Acceptable Range: Span (300.0 ± 0.1 mV for STOLAB PL-0/30C)
Adjustment is the Span Pot on STOLAB Circuit Card

	Unadjusted	Adjusted
Circuit Reading:	mV	mV

SRP Circuit

(1) Measurement is taken from front panel jacks for temperature.
(2) Set SRP to "Cal" position.
(3) Set the STOLAB at 0°C and set voltmeter to read mV DC.
Acceptable Range: Zero (0.1 to 1.0 mV)
Adjustment is the Zero Pot on the front panel.

	Unadjusted	Adjusted
Circuit Reading:	mV	mV

(1) Set the STOLAB at 30°C or 100°C.
(2) Set SRP to "Run" position**. STABILITY MONITOR MUST BE ON TEMPORARILY**.
Acceptable Range: Span (30.000 ± 0.010 °C or 100.00 ± 0.010 °C)
Adjustment is the Span Pot on the front panel.

	Unadjusted	Adjusted
Circuit Reading:	°C	°C

NOTE: If any one of these settings needed to be corrected then all readings need to be re-measured.
REMINDER: UNPLUG STOLAB AND RE-CONNECT TEMPERATURE PROBE!

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3. SRP PRESSURE

A. SRP Circuit Zero (Switch to Cal on SRP)
RANGE: 700.0 mb (±0.1 mb)

	Unadjusted		Adjusted	
SRP Readout:		mb	SRP Readout:	mb

B. SRP Circuit Span (Switch to Run on SRP)
RANGE: (±0.2 mb)

	Unadjusted		Adjusted	
Lab Standard:		mb	Lab Standard:	mb
SRP Readout:		mb	SRP Readout:	mb
Note: Adjustments made to SRP circuit span affect SRP circuit zero and vice-versa. This process may involve several iterations of zero and span adjustments.				

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4. UV SOURCE TYPE AND BLOCK TEMPERATURE

UV Detector Lamp	Type:		S/N:	
	Unadjusted	Adjusted		
Detector Block Temp:				
Ozone Gen. Temp:				

5. DARK COUNTS

RANGE: (5-20) Close shutter, start stability monitor. Adjust scaler pots if necessary.

	Unadjusted	Adjusted
Cell #1:		
Cell #2:		

6. TOTAL COUNTS

RANGE: (90,000-250,000) Adjust detector block temp. if necessary.

	Unadjusted	Adjusted
Cell #1:		
Cell #2:		

7. PRECISION

Run the Stability Monitor Diagnostic Program (**10 cycles / 20 replicates/cycle**)
Saved as File Name: dstab011.xls Paste the Diagnostic Test Report from the Stability Monitor here:

See File Name: dstab0__.xls (example)

Diagnostic Test Report

Stability Monitor

Calibrating Institute: USEPA Region **Date:**

Operator: **File Name:** dstab0___.xls

Instruments: SRP-__

Comment: Reps = 20; Cycles = 10

		Temp	Pressure	Scaler1	Scaler2	Ratio
1	Average:	23.85	995.0	96028	94782	1.013148
	Std Dev:	0.00	0.0	13	13	0.000012
2	Average:	23.87	995.0	96010	94761	1.013182
	Std Dev:	0.01	0.0	12	12	0.000019
3	Average:	23.89	995.0	96006	94750	1.013253
	Std Dev:	0.01	0.1	10	9	0.000021
4	Average:	23.93	994.9	95990	94731	1.013294
	Std Dev:	0.01	0.0	5	5	0.000010
5	Average:	23.98	994.9	95980	94719	1.013312
	Std Dev:	0.01	0.0	12	12	0.000010
6	Average:	24.02	994.9	95956	94695	1.013320
	Std Dev:	0.01	0.0	9	9	0.000011
7	Average:	24.07	995.0	95974	94715	1.013295
	Std Dev:	0.01	0.1	6	7	0.000021
8	Average:	24.09	995.1	95998	94744	1.013240
	Std Dev:	0.00	0.0	14	14	0.000017
9	Average:	24.09	995.2	96008	94759	1.013182
	Std Dev:	0.00	0.1	11	12	0.000020
10	Average:	24.08	995.1	96023	94776	1.013158
	Std Dev:	0.00	0.0	10	10	0.000019

Acceptable Criteria:

Each Scaler 1 and Scaler 2 standard deviation from cycle 7 thru 10 must be less than 25.
Each ratio standard deviation from cycle 7 thru 10 must be less than 0.000030.

8. COMMENTS

9. FLOW RATES (optional)

NOTE: All flow measurements are not corrected for Barometric Pressure and Temperature

Gillian Gilabrator-

SRP-1:Zero Air Pressure set at XX PSIG

Sample Input -- Cell 1 (Valve1 - Ozone, Valve2 - Air): Black Ball ; °C; mb , , , , , cc/min
Average cc/min

Sample Input -- Cell 2 (Valve 1 - Air, Valve 2 - Ozone): Black Ball ; °C; mb , , , , , cc/min
Average cc/min

Reference Input -- Cell 1 (Valve 1 - Air, Valve 2 - Ozone): Black Ball ; °C; mb , , , , , cc/min
Average cc/min

Reference Input -- Cell 2 (Valve1 - Ozone, Valve2 - Air): Black Ball ; °C; mb , , , , , cc/min
Average cc/min

Reference Air Out: -- °C, mb, , , , , cc/min
Average cc/min

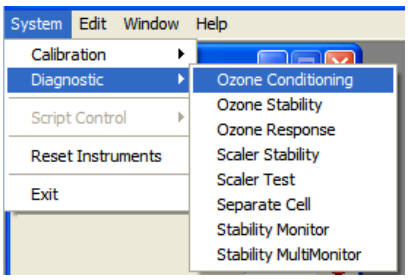
Ozone Sample Out: -- Mass Flow Controller Set at LPM , °C, mb, , , , , cc/min
Average cc/min

Cell 1 Exhaust: -- °C, mb, , , , , cc/min
Average cc/min

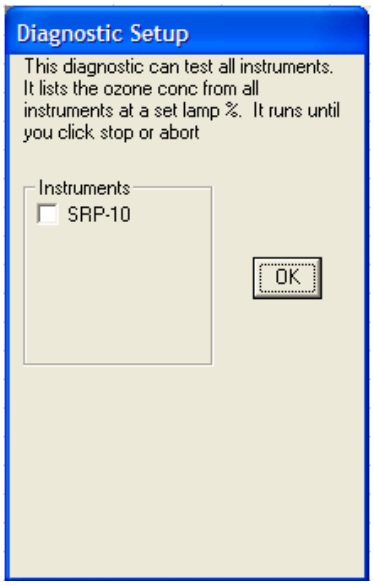
Cell 2 Exhaust: -- °C, mb, , , , , cc/min
Average cc/min

4.3 Diagnostics/Scripts

In addition to the previously mentioned Stability Monitor there are several other diagnostic scripts that can be accessed under the "***System/Diagnostic***" menu option as shown below. The Diagnostic form will appear when any of the diagnostic scripts are chosen.



Diagnostic Form:



The diagnostic form will show a description of the diagnostic script in the upper portion of the form. You choose the instruments that you want to run the diagnostic on in the "***Instrument***" section. If there are round option buttons here, then only one instrument can be chosen. If there are square checkboxes here, then multiple instruments can be chosen.

Various other options are shown depending on the diagnostic. When the "***Print Status Report Window***" option is checked the status window will be automatically printed to the default windows printer before each clear.

The available scripts are:

1. *Ozone Conditioning*: This diagnostic can test all instruments. It lists the O_3 concentration from all instruments at a set lamp percent. It runs until you click stop or abort. This is useful for determining what lamp percentage at a given flow rate produces the desire concentration of O_3. The data can be exported to an Excel™ spreadsheet, but seems to be limited to about 500 rows.

Ozone Stability: This diagnostic test runs only on SRPs. It lists the Scaler1, Scaler2, and O_3 concentrations. You may run up to 100 repeat readings in up to 100 cycles.

2. *Ozone Response*: This diagnostic test runs only on SRPs. It calculates the O_3 concentration in each cell, and the ratio of those concentrations. The lamp starts at zero, ramps to full, then back to zero.
3. *Scaler Stability*: This diagnostic test runs only on SRPs. It lists the Scaler1, Scaler2, and scaler ratio. You may run up to 100 repeat readings in up to 100 cycles.
4. *Scaler Test*: This diagnostic test runs only on SRPs. It lists the Temperature, Pressure, Scaler1, Scaler2, and scaler ratio. It runs until you click the stop or abort button.
5. *Separate Cell*: This diagnostic test runs only on SRPs. It calculates individual cell O_3 concentrations, and the ratio of those concentrations. You may run up to 100 repeat readings in up to 100 cycles.
6. *Stability Monitor*: This diagnostic test runs only on SRPs. It lists the Temperature, Pressure, Scaler1, Scaler2, and scaler ratio. You may run up to 100 repeat readings in up to 100 cycles. This diagnostic generates an Excel™ Report using the DiagReport.xls template. The Scaler Monitor test should be run using 20 repeat readings for 10 cycles. The last three averages standard deviation of the Scaler1 & Scaler2 less than 25 and the ratio readings should be less than 0.00003.
7. *Stability MultiMonitor*: This diagnostic test runs multiple SRPs at the same time. It lists each of SRPs Temperature, Pressure, Scaler1, Scaler2, and scaler ratios for each. Still you may run up to 100 repeat readings in up to 100 cycles. The typical scaler test should be 20 repeat readings in 10 cycles. If the shutter is closed before starting the stability test the SRP will then read the dark counts (see SRP OPERATING CHARACTERISTICS DATA SHEET Section 5). If the shutter is left closed the SRP Program will automatically abort the run after a few minutes.

Scripts subdirectory contains the above seven scripts through diagnostics and two additional scripts through calibration (see directory listing):